

PATENT CLAIMS

1. A converter circuit for switching a large number of switching voltage levels, having n first switching groups (1.1, ..., 1. n) which are provided for each phase (R, Y, B), with the n -th first switching group (1. n) being formed by a first power semiconductor switch (2) and a second power semiconductor switch (3), and with the first first switching group (1.1) to the ($n-1$)-th switching group (1.($n-1$)) each being formed by a first power semiconductor switch (2) and a second power semiconductor switch (3) and by a capacitor (4), which is connected to the first and second power semiconductor switches (2, 3), with each of the n first switching groups (1.1, ..., 1. n) being connected in series to the respectively adjacent first switching group (1.1, ..., 1. n), and with the first and the second power semiconductor switches (2, 3) in the first first switching group (1.1) being connected to one another, characterized in that $n \geq 1$ and p second switching groups (5.1, ..., 5. p) and p third switching groups (6.1, ..., 6. p) are provided, which are each formed by a first power semiconductor switch (2) and a second power semiconductor switch (3) and by a capacitor (4) which is connected to the first and second power semiconductor switches (2, 3), where $p \geq 1$ and each of the p second switching groups (5.1, ..., 5. p) is connected in series with the respectively adjacent second switching group (5.1, ..., 5. p), and each of the p third switching groups (6.1, ..., 6. p) is connected in series with the respectively adjacent third switching group (6.1, ..., 6. p), and the first second switching group (5.1) is connected to the first power

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- semiconductor switch (2) in the n-th first switching group (1.n), and the first third switching group (6.1) is connected to the second power semiconductor switch (3) in the n-th first switching group (1.n), and
- 5 in that the capacitor (4) in the p-th second switching group (5.p) is connected in series with the capacitor (4) in the p-th third switching group (6.p).
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2. The converter circuit as claimed in claim 1, characterized in that a voltage limiting network (7) is connected in parallel with the first power semiconductor switch (2) in the n-th first switching group (1.n), and
- 15 in that a voltage limiting network (7) is connected in parallel with the second power semiconductor switch (3) in the n-th first switching group (1.n).
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3. The converter circuit as claimed in claim 2, characterized in that the voltage limiting network (7) has a capacitor.
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4. The converter circuit as claimed in claim 2, characterized in that the voltage limiting network (7) has a series circuit formed by a resistor with a capacitor.
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5. The converter circuit as claimed in claim 1, characterized in that the n-th first switching group (1.n) has a capacitor (4) which is connected to the first and second power semiconductor switches (2, 3) in the n-th first switching group (1.n), with the first second switching group (5.1) being connected to the capacitor (4) in the n-th first switching group (1.n), and with the first
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third switching group (6.1) being connected to the capacitor (4) in the n-th first switching group (1.n).

5 6. The converter circuit as claimed in one of claims
1 to 4, characterized in that the first and second
power semiconductor switches (2, 3) in the first
second switching group (5.1) are connected to one
another, with the junction point of the first and
10 second power semiconductor switches (2, 3) in the
first second switching group (5.1) being connected
to the first power semiconductor switch (2) in the
n-th first switching group (1.n), and in that the
first and second power semiconductor switches (2,
15 3) in the first third switching group (6.1) are
connected to one another, with the junction point
of the first and second power semiconductor
switches (2, 3) in the first third switching group
(6.1) being connected to the second power
20 semiconductor switch (3) in the n-th first
switching group (1.n).

7. The converter circuit as claimed in claim 5,
characterized in that the first and second power
25 semiconductor switches (2, 3) in the first second
switching group (5.1) are connected to one
another, with the junction point of the first and
second power semiconductor switches (2, 3) in the
first second switching group (5.1) being connected
30 to the junction point of the capacitor (4) in the
n-th first switching group (1.n) and the first
power semiconductor switch (2) in the n-th first
switching group (1.n), and
in that the first and second power semiconductor
35 switches (2, 3) in the first third switching group
(6.1) are connected to one another, with the
junction point of the first and second power

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semiconductor switches (2, 3) in the first third switching group (6.1) being connected to the junction point of the capacitor (4) in the n-th first switching group (1.n) and the second power semiconductor switch (3) in the n-th first switching group (1.n).

8. The converter circuit as claimed in one of claims 1 to 7, characterized in that the total number of the n first switching groups (1.1, ..., 1.n) corresponds to the total number of the p second and third switching groups (5.1, ..., 5.p; 6.1, ..., 6.p).

9. The converter circuit as claimed in one of claims 1 to 7, characterized in that the total number of the n first switching groups (1.1, ..., 1.n) is less than the total number of the p second and third switching groups (5.1, ..., 5.p; 6.1, ..., 6.p).

10. The converter circuit as claimed in one of claims 1 to 7, characterized in that the total number of the n first switching groups (1.1, ..., 1.n) is greater than the total number of the p second and third switching groups (5.1, ..., 5.p; 6.1, ..., 6.p).

11. The converter circuit as claimed in one of claims 1 to 10, characterized in that the first power semiconductor switch (2) and the second power semiconductor switch (3) in each switching group (1.1, ..., 1.n; 5.1, ..., 5.p; 6.1, ..., 6.p) are in each case in the form of a bidirectional power semiconductor switch.

12. The converter circuit as claimed in one of claims

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- 1 to 10, characterized in that the first power semiconductor switch (2) in each first and in each second switching group (1.1, ..., 1.n; 5.1, ..., 5.p) is a bidirectional power semiconductor switch,
- 5 in that the second power semiconductor switch (3) in each first and in each third switching group (1.1, ..., 1.n; 6.1, ..., 6.p) is a bidirectional power semiconductor switch,
- 10 and
- in that the second power semiconductor switch (3) in each second switching group (5.1, ..., 5.p) and the first power semiconductor switch (2) in each third switching group (6.1, ..., 6.p) are in each case in the form of a unidirectional power semiconductor switch.
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13. The converter circuit as claimed in one of claims 1 to 10, characterized in that the first power semiconductor switch (2) in each first and in each third switching group (1.1, ..., 1.n; 6.1, ..., 6.p) is a bidirectional power semiconductor switch,
- 20 in that the second power semiconductor switch (3) in each first and in each second switching group (1.1, ..., 1.n; 5.1, ..., 5.p) is a bidirectional power semiconductor switch, and
- 25 in that the first power semiconductor switch (2) in each second switching group (5.1, ..., 5.p) and the second power semiconductor switch (3) in each third switching group (6.1, ..., 6.p) is a unidirectional power semiconductor switch.
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14. The converter circuit as claimed in one of claims 1 to 10, characterized in that the first power semiconductor switch (2) and the second power semiconductor switch (3) in each first switching
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- group (1.1, ..., 1.n) are in each case in the form of a bidirectional power semiconductor switch, and in that the first power semiconductor switch (2) and the second power semiconductor switch (3) in each second switching group (5.1, ..., 5.p) and in each third switching group (6.1, ..., 6.p) are in each case in the form of a unidirectional power semiconductor switch.
- 10 15. The converter circuit as claimed in one of claims 11 to 14, characterized in that the bidirectional power semiconductor switch is formed by an electronic component which can be driven and carries current in only one direction, and by a passive electronic component which is connected back-to-back in parallel with this, cannot be driven and carries current in only one direction.
- 15 16. The converter circuit as claimed in one of claims 12 to 15, characterized in that the unidirectional power semiconductor switch is formed by a passive electronic component which cannot be driven and carries current in only one direction.
- 20 17. The converter circuit as claimed in one of the preceding claims, characterized in that, in the case of the n first switching groups (1.1, ..., 1.n), the two first power semiconductor switches (2) in respectively adjacent first switching groups (1.1, ..., 1.n) are integrated in a module, and the two second power semiconductor switches (3) in respectively adjacent first switching groups (1.1, ..., 1.n) are integrated in a module.
- 25 30 18. The converter circuit as claimed in claim 17, characterized in that, in the case of the p second switching groups (5.1, ..., 5.p), the two first
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- power semiconductor switches (2) in respectively adjacent second switching groups (5.1, ..., 5.p) are integrated in a module, and the two second power semiconductor switches (3) in respectively adjacent second switching groups (5.1, ..., 5.p) are integrated in a module, and in that, in the case of the p third switching groups (6.1, ..., 6.p), the two first power semiconductor switches (2) in respectively adjacent third switching groups (6.1, ..., 6.p) are integrated in a module, and the two second power semiconductor switches (3) in respectively adjacent third switching groups (6.1, ..., 6.p) are integrated in a module.
19. The converter circuit as claimed in one of claims 1 to 16, characterized in that, in the case of the n first switching groups (1.1, ..., 1.n) and in the case of the p second and third switching groups (5.1, ..., 5.p; 6.1, ..., 6.p), the first power semiconductor switch (2) and the second power semiconductor switch (3) are in each case integrated in a module.
20. The converter circuit as claimed in one of the preceding claims, characterized in that, if there are a plurality of phases (R, Y, B), the p-th second switching groups (5.p) for the phases (R, Y, B) are connected in parallel with one another, and the p-th third switching groups (6.p) for the phases (R, Y, B) are connected in parallel with one another.
21. The converter circuit as claimed in claim 20, characterized in that the capacitors (4) in the p-th second switching groups (5.p) for the phases (R, Y, B) are combined to form one capacitor, and

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in that the capacitors (4) in the p-th third switching groups (6.p) for the phases (R, Y, B) are combined to form one capacitor.